Wet FGD Mercury Control for Coal-Fired Utility Boilers

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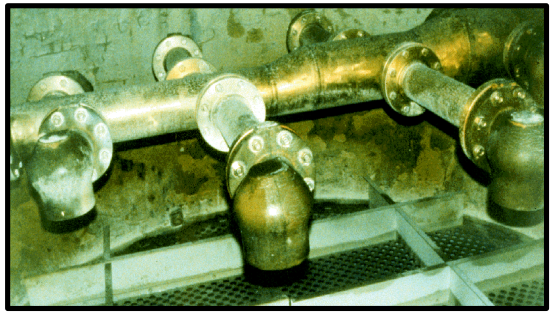
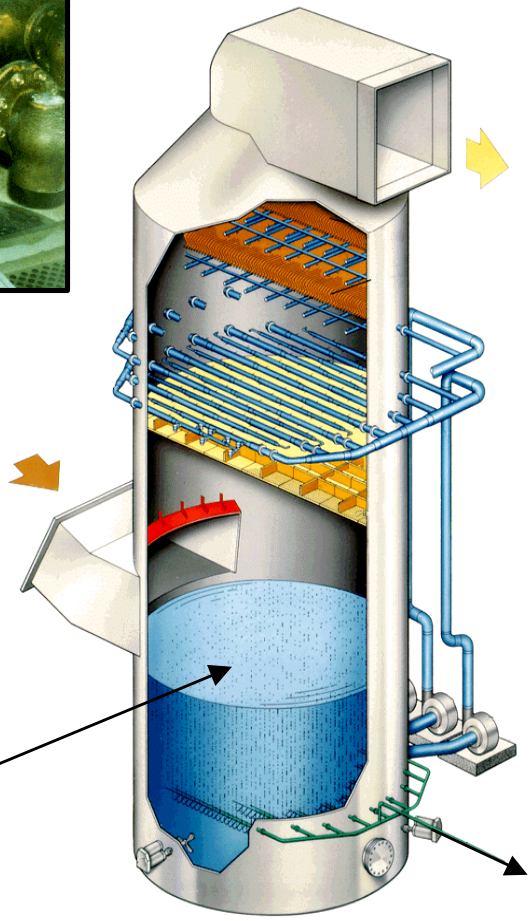
Babcock & Wilcox

US Department of Energy / Ohio Coal Development Office
Babcock & Wilcox / MTI

Wet FGD Mercury Control for Coal-Fired Utility Boilers

B&W Wet SO_2 Scrubber





Flue Gas Outlet

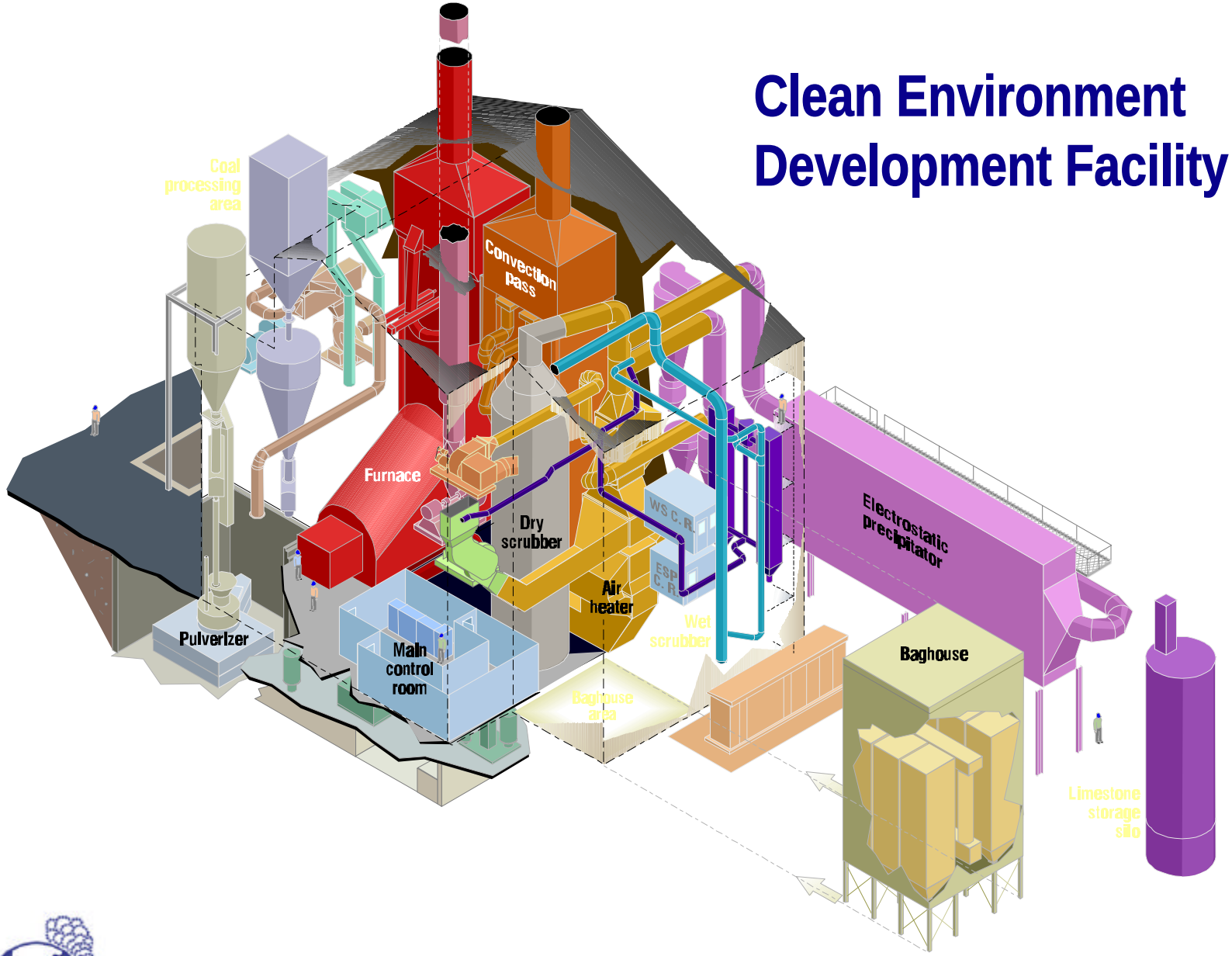
Limestone or Lime Slurry Spray

Flue Gas Inlet

Limestone or Lime Slurry

Spent Slurry or Gypsum

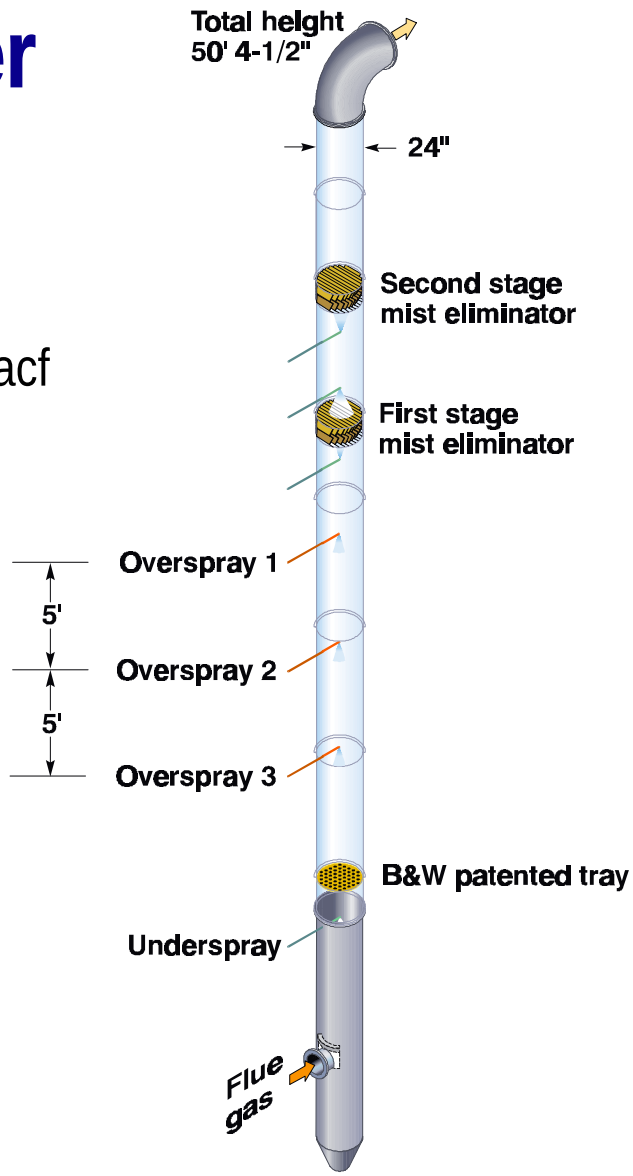
Clean Environment Development Facility (CEDF)



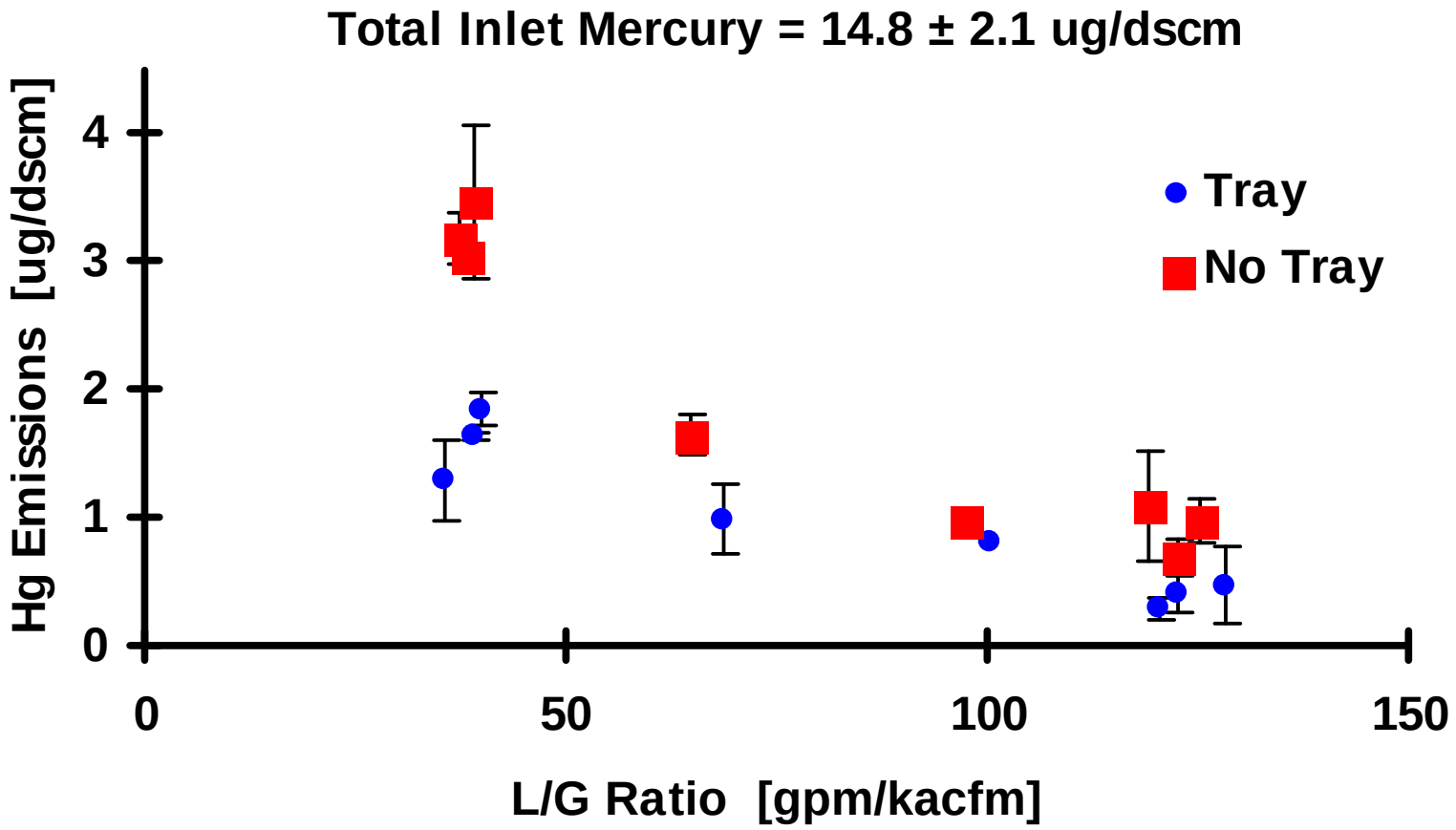
B&W / MTI Pilot Wet Scrubber

Typical Operating Conditions

Inlet Gas Flow	2,100 acfm
Slurry pH	5.4 - 5.6
L/G Ratio	120 gal / 1,000 acf
SO_2 Removal / Slurry Oxidation	95% / >99%

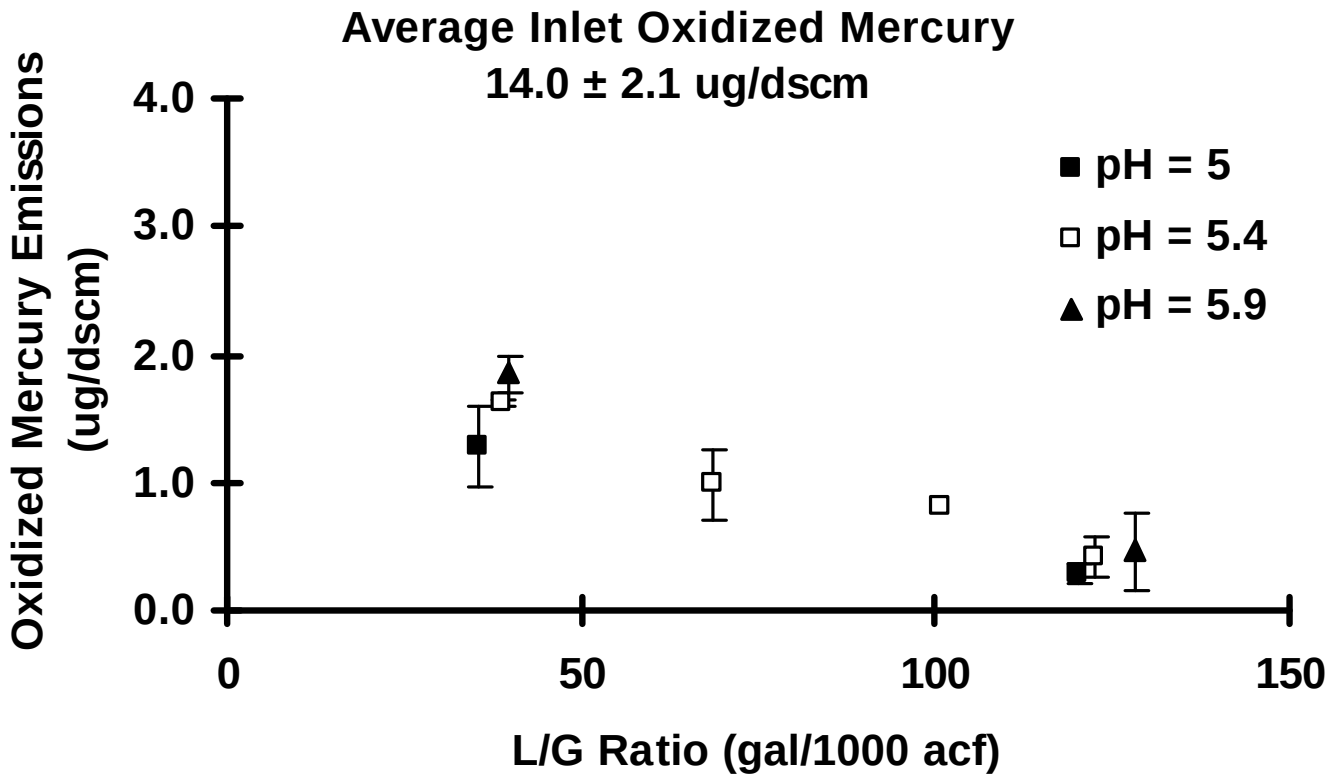


AECDP Pilot Results - mid 1990's



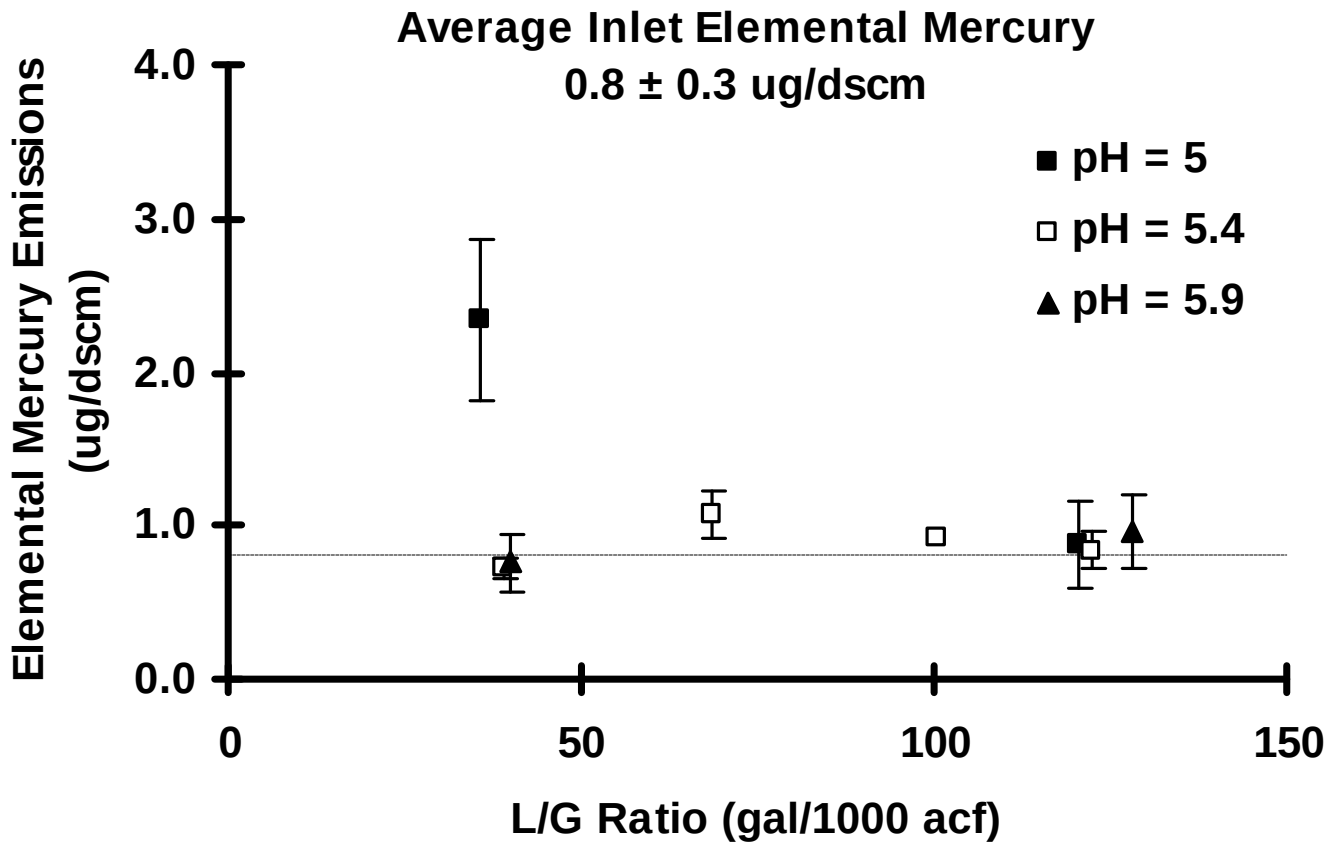
FGD Design and Operation Impacts Mercury Control

AECDP Pilot Results - mid 1990's



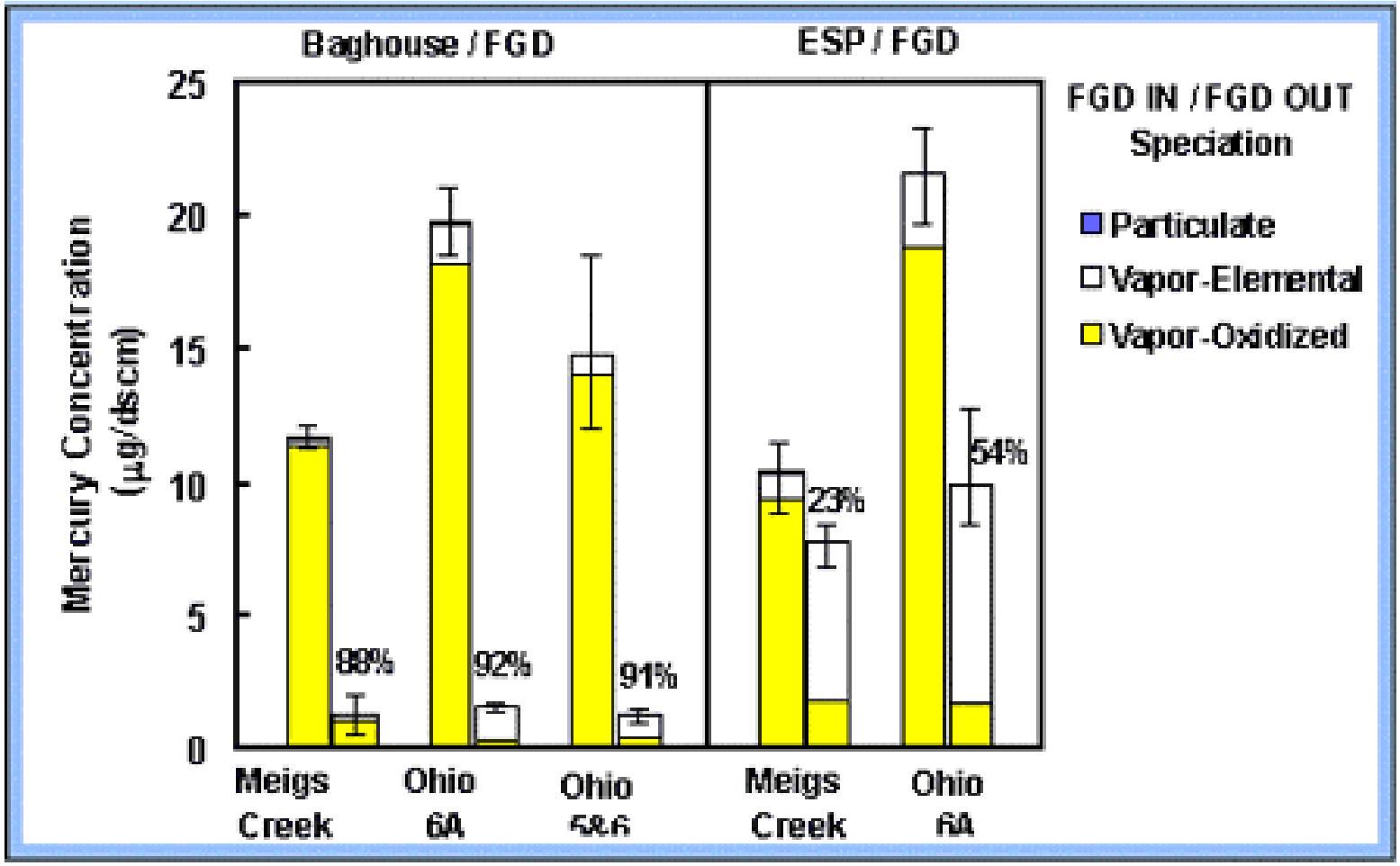
Oxidized Mercury Removal at 85% to 98%

AECDP Pilot Results - mid 1990's



Limited Impact on Elemental Mercury

AECDP Pilot Results - mid 1990's

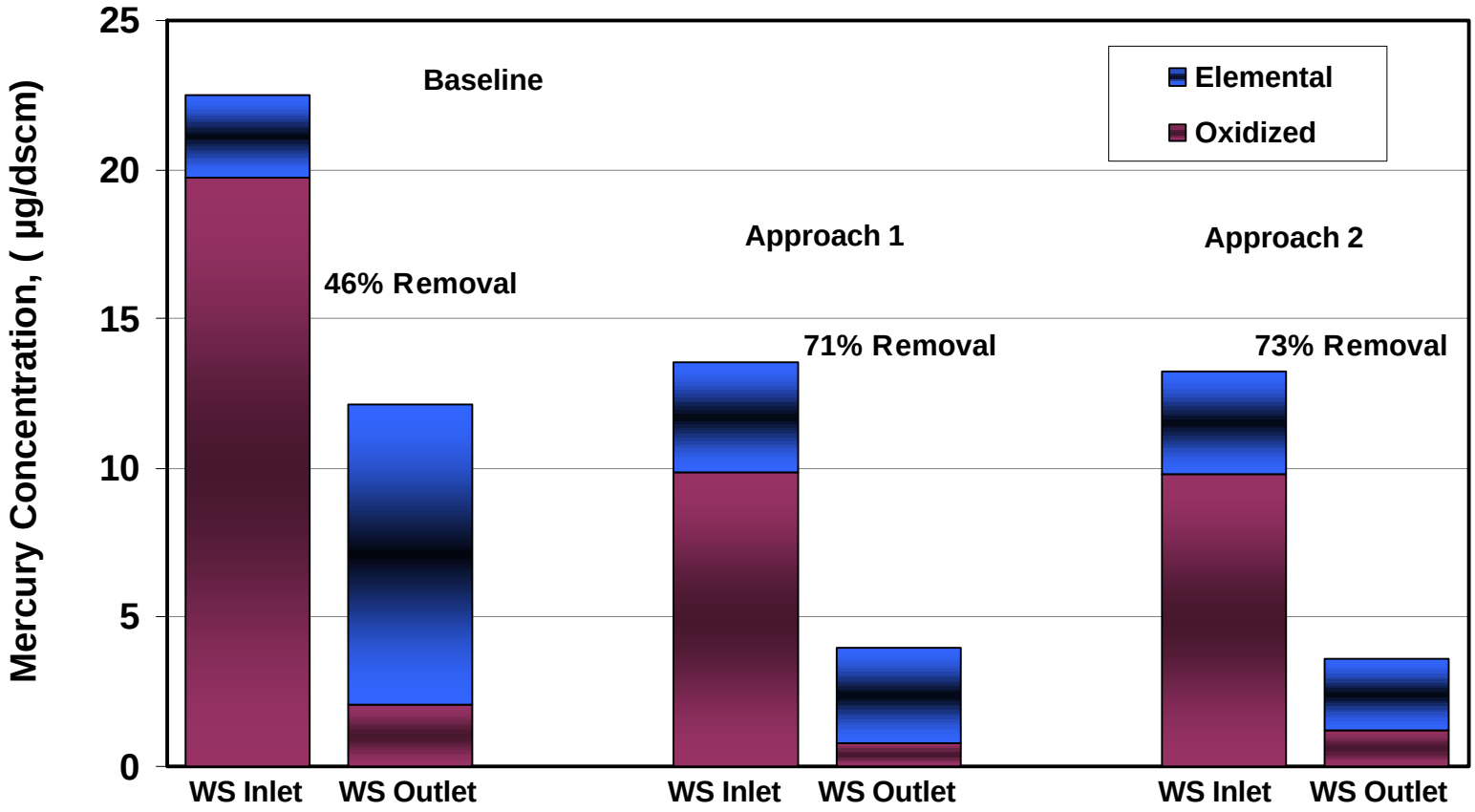


Favorable oxidized/elemental split does not assure high removal efficiency

Wet Scrubber Performance Optimization

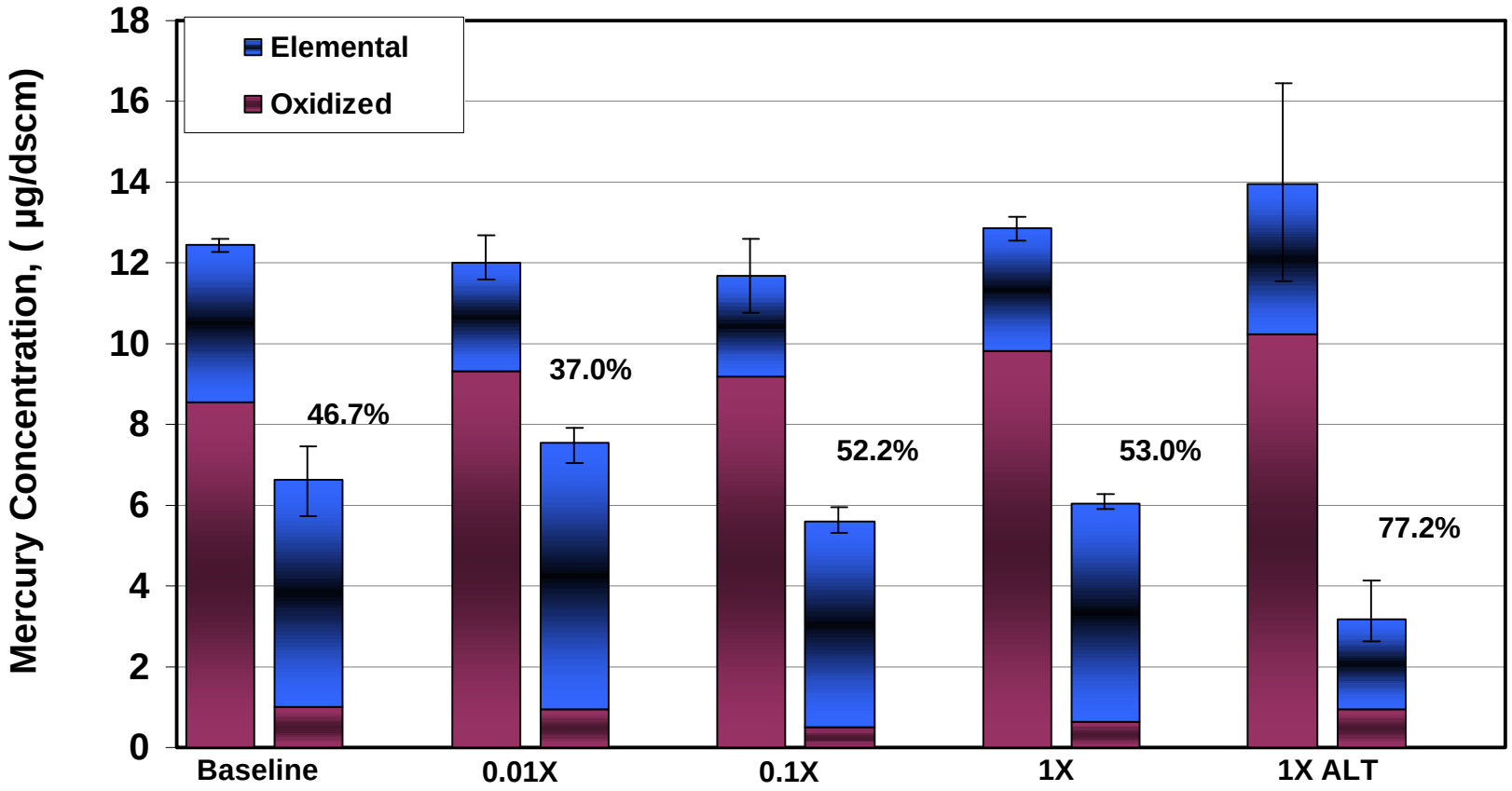
- **Additives**
  - Different reagents
  - Different means of injection
- **Hg Sampling**
  - Triplicate Ontario Hydro sample trains performed at wet scrubber inlet and outlet for each specific test condition
  - Process samples (coal, slurry, ESP ash) collected for each test condition
  - PS Analytical Sir Galahad Hg analyzer on-site for qualitative determination of Hg control performance

AECDP WFGD Control Enhancement Results



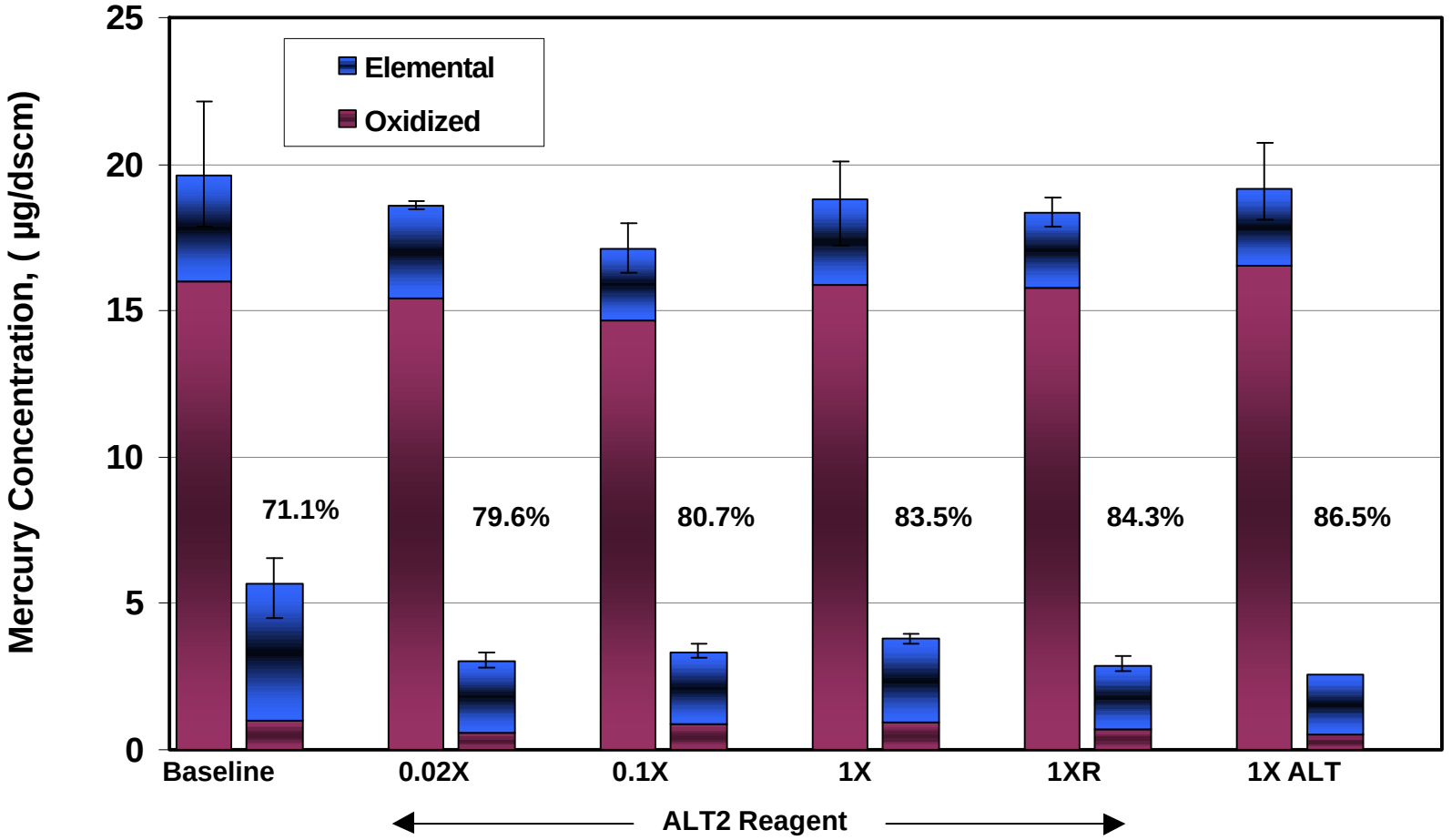
Effective, convenient method of reagent addition

Test Series #1 Hg Removal Results



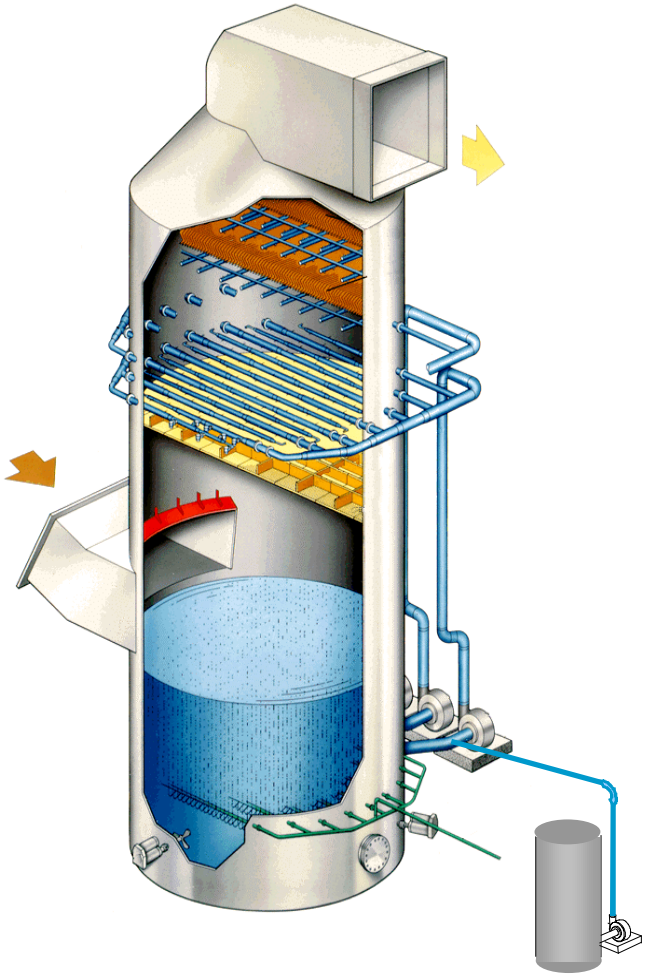
Safe, stable reagent proves effective

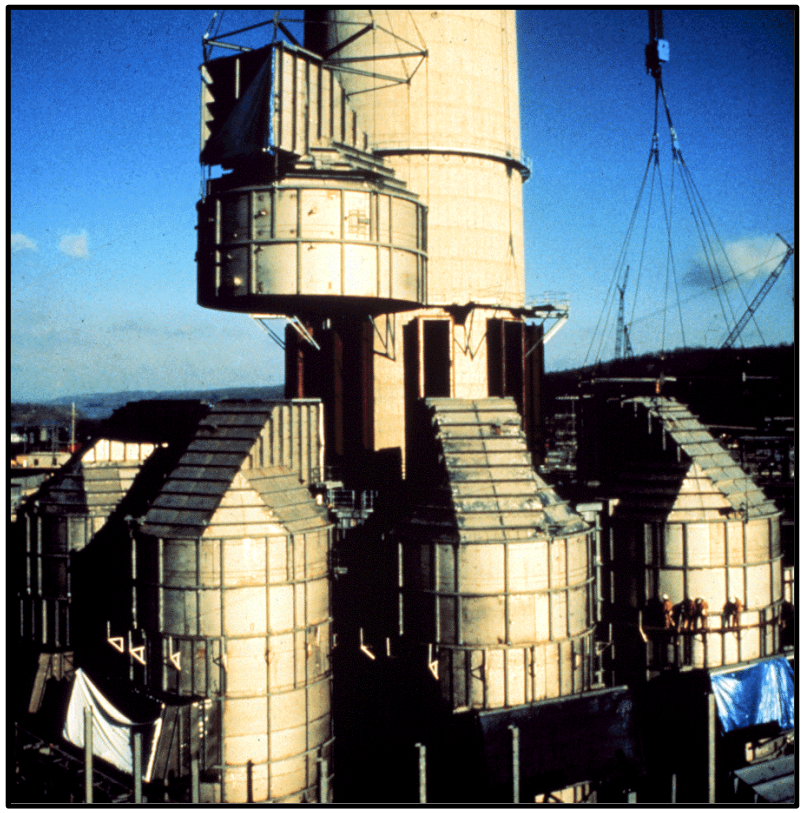
Test Series #2 Hg Removal Results



Alternate reagent provides comparable results

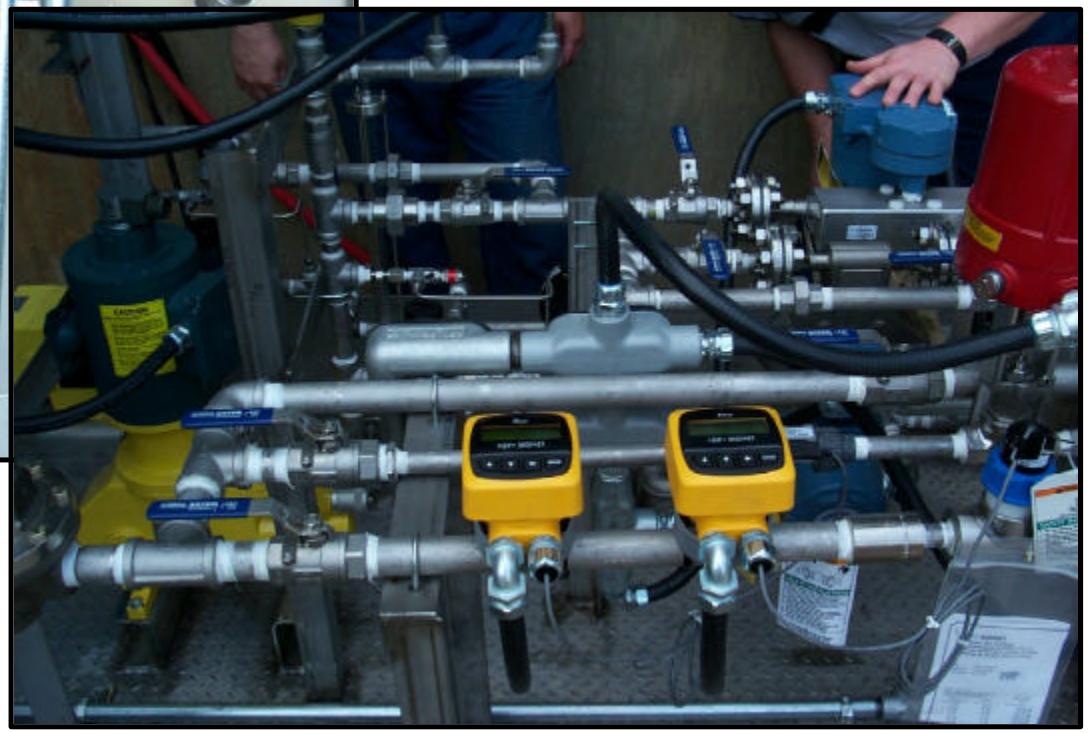
Full Scale Demonstration Tests





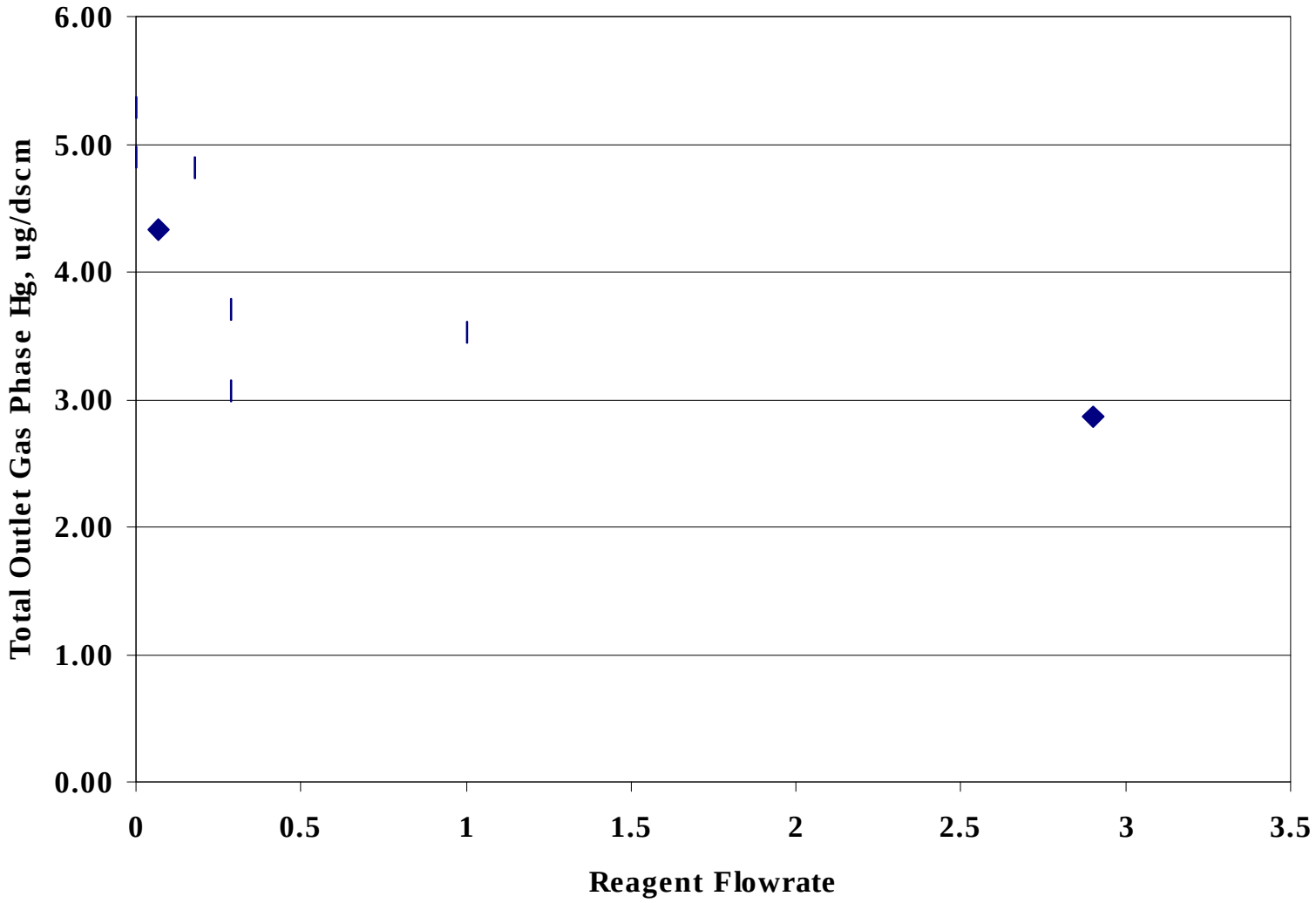
Mercury Removal
Chemical Addition

Reagent Injection Skid for Demonstration Tests

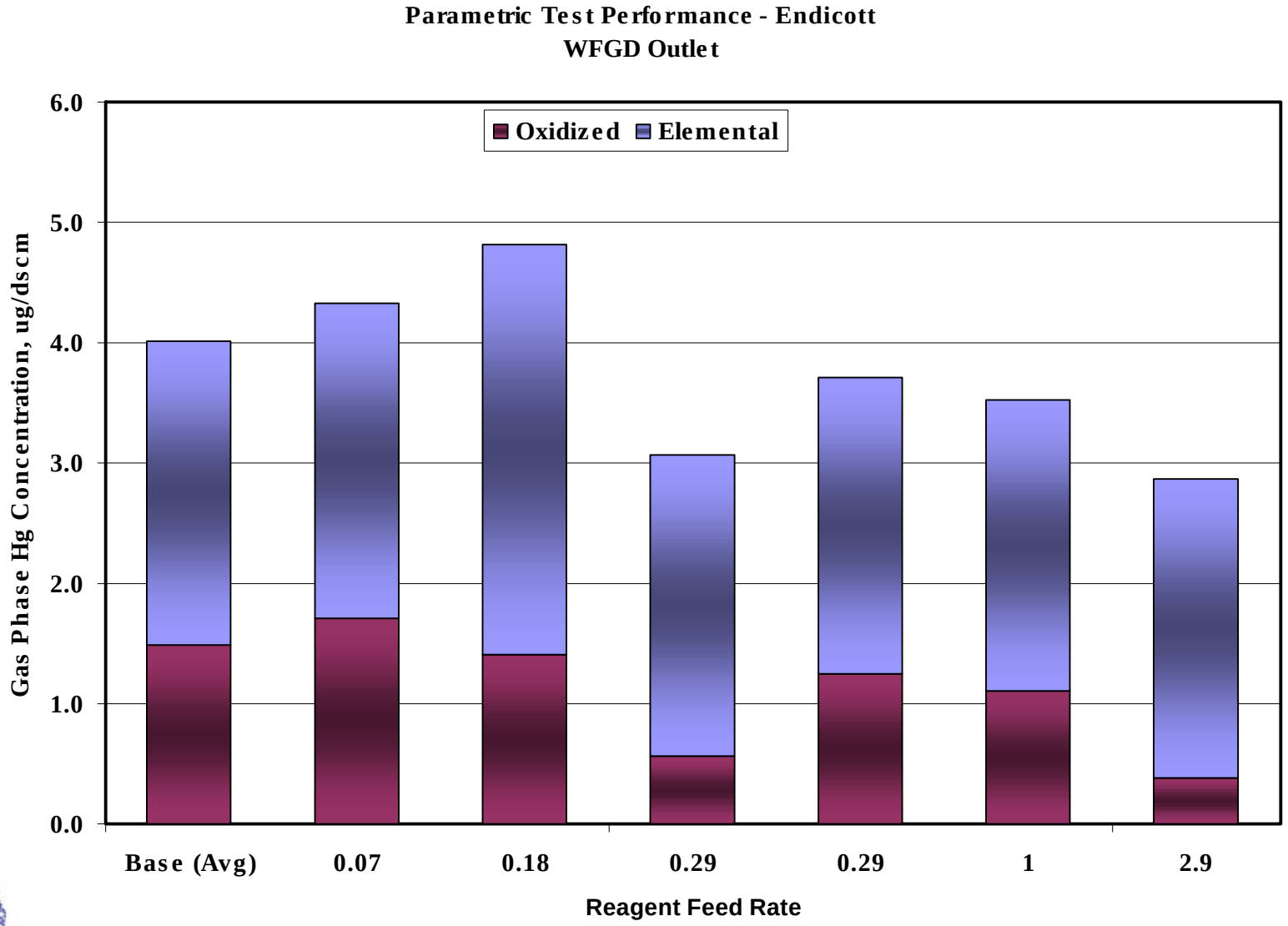


MSCPA Endicott - 55 MW / Limestone / In-situ oxidation

Full-Scale Parametric Tests - MSCPA



Full-Scale Parametric Tests - MSCPA

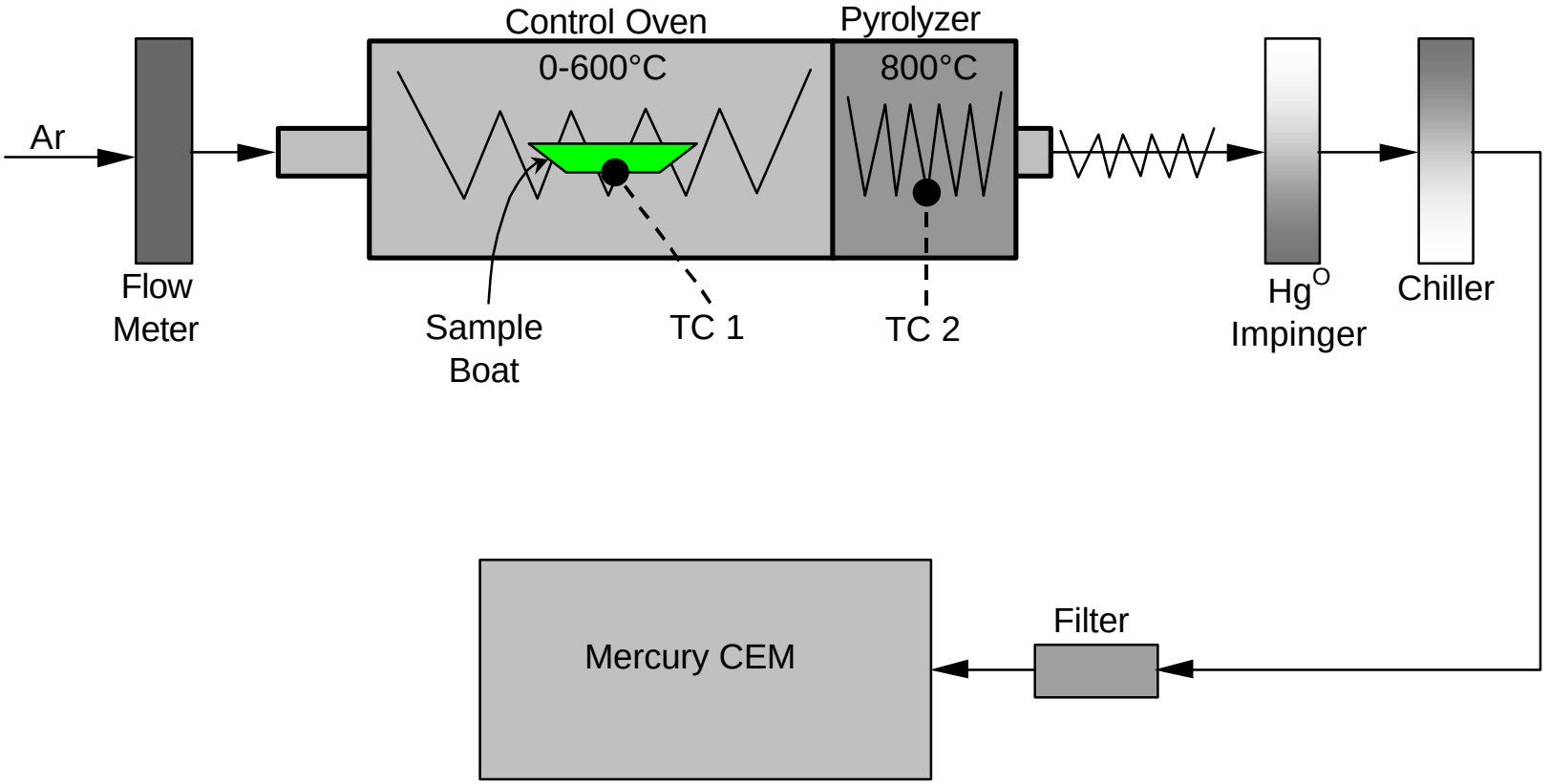


Cinergy Zimmer - 1300 MW / Thiosorbic Lime / Ex-situ oxidation

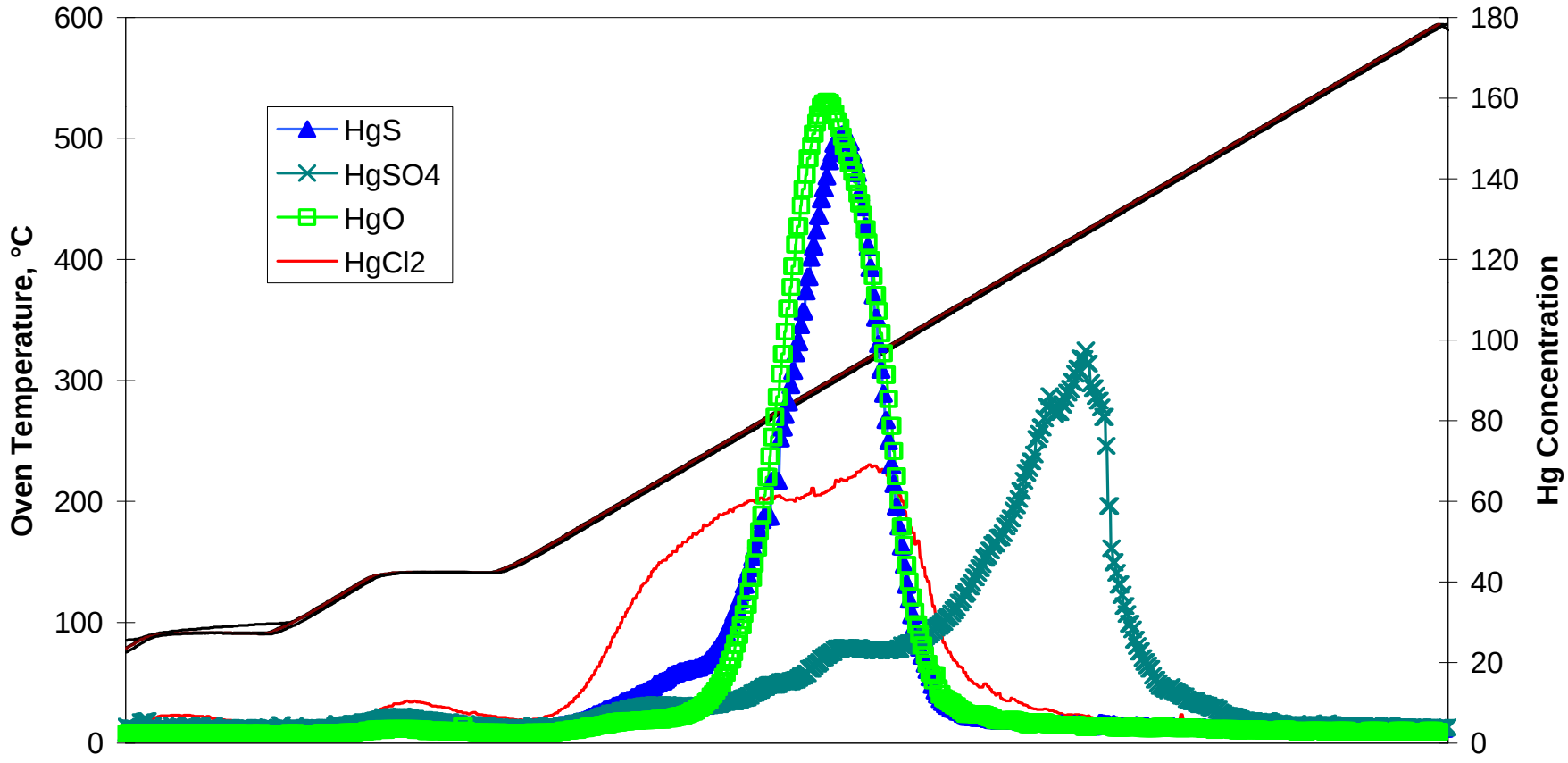
Fate of Mercury - FGD Byproducts

- **Mercury found mainly in solid phase**
  - Filtrate samples - < 0.0005 mg/l
  - Solids samples - 0.064 to 0.190 mg/kg
  - Suggests mercury not in soluble form (not $HgCl_2$)
- **Solids leaching tests (TCLP / HNO_3 / HNO_3 and HCl)**
  - TCLP results generally non-detect (< 0.21 mg/kg)
  - Strong acid digestion suggests mercury not strongly tied to ash or gypsum
  - Acids used were much stronger than would be encountered naturally
  - No impact of additive observed
- **Thermal Decomposition Tests**
  - PSA continuous mercury analyzer
  - Mercury appears in the byproduct as $HgSO_4$ and either HgO and/or HgS

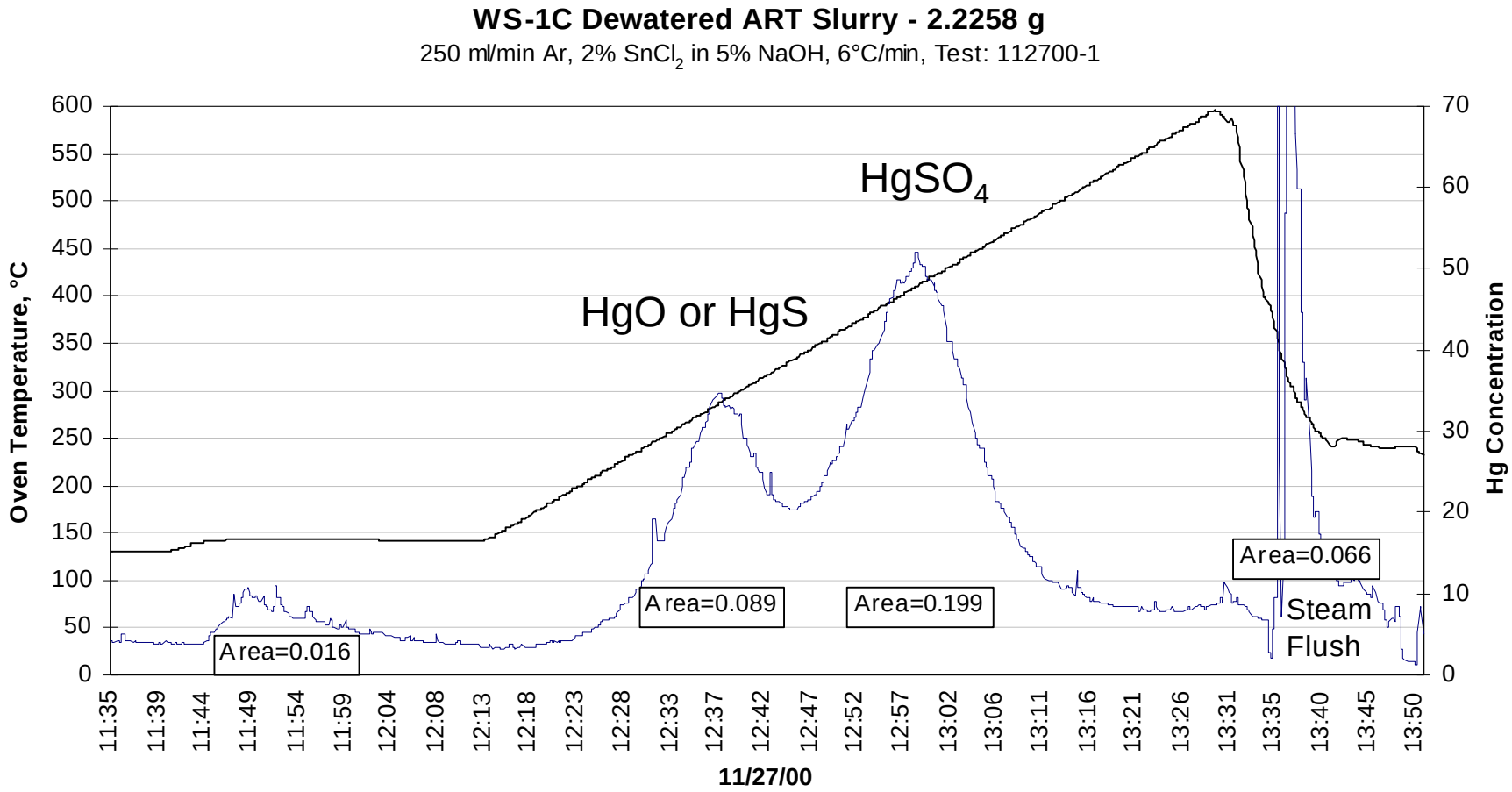
Thermal Decomposition Analysis



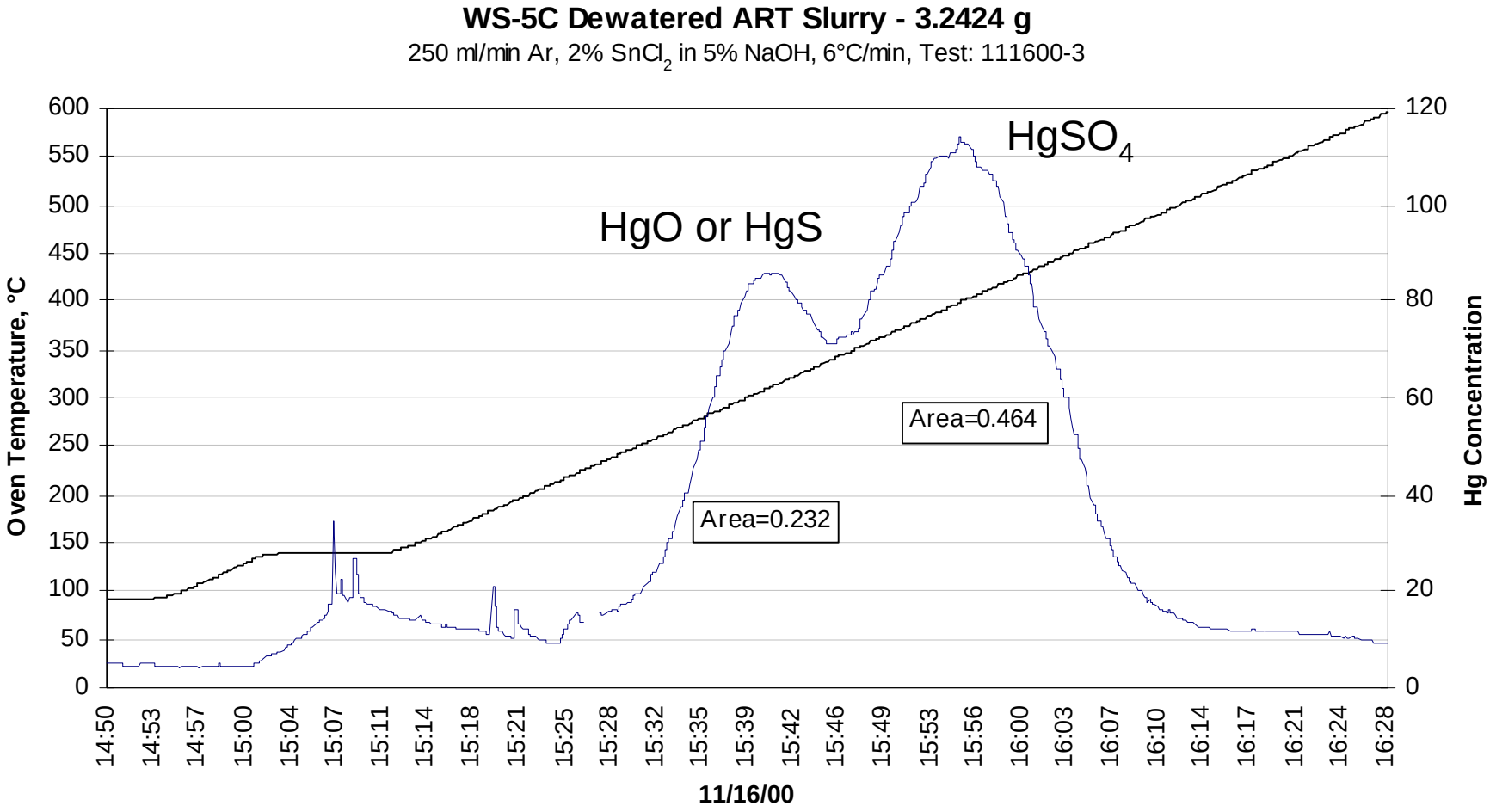
Thermal Decomposition Curve (TDC) for Hg Standards



TDC for Pilot WFGD Solids
(Baseline - 47% Reduction)



TDC for Pilot WFGD Solids
(Alt. Approach 1 - 77% Reduction)



EPA ICR Data - Wet FGD Mercury Control

PC Fired Boilers - Baghouse and Wet FGD

	Wet FGD Mercury Emissions Reduction %	
	Range	Average
Lignite (No sites)		
Sub-Bituminous (No sites)		
Bituminous (2 sites)	58 - 86	72

- Average inlet Hg^0 (33% of total)
- Design L/G 60 and 100 gpm/kacfm
- Open spray towers
- 90% SO_2 removal
- Natural oxidation

EPA ICR Data - Wet FGD Mercury Control

PC Fired Boilers - Cold Side ESP and Wet FGD

	Mercury Emissions Reduction %	
	Range	Average
Lignite (2 sites)	21 - 56	44
Average inlet Hg^0 (46%)		
Sub-Bituminous (3 sites)	0 - 57	25
High average inlet Hg^0 (72%)		
Bituminous (1 site)	62 - 68	64
Average inlet Hg^0 (30%)		
Design L/G 138 gpm/acfm		
Open spray towers		
95% SO_2 removal (Formic acid addition)		
Forced oxidation		

EPA ICR Data - Wet FGD Mercury Control

PC Fired Boilers - Hot Side ESP and Wet FGD

	Mercury Emissions Reduction %	
	Range	Average
Lignite (No sites)		
Sub-Bituminous (5 sites)	3 - 43	29
Average inlet Hg^0 (61%)		
Bituminous (1 site)	45 - 53	49
Average inlet Hg^0 (31%)		
Outlet Hg^0 +19% over inlet Hg^0		
Design L/G 50 gpm/acfm		
Venturi tower		
52.7% SO_2 removal		
Natural oxidation		

EPA Perspective on Wet FGD Mercury Control

- **Current Level of Control (ICR Data)**

	Bituminous	Sub-bituminous
ESP & WFGD	80	0
FF & WFGD	90	75

- **Near-Term Potential (2007 -2008)**

	Bituminous	Sub-bituminous
ESP & WFGD	90	50
FF & WFGD	90	85

Source: Robert J. Wayland, US EPA ,Northeast Midwest Institute/ECOS Meeting, July, 2001

OEM Perspective on Wet FGD Mercury Control

- **Mercury control variation may reflect inherent differences in system designs**
  - Liquid -to-Gas Ratio (L/G)
  - Tray Tower vs. Open Spray Tower
  - Oxidation (Forced / Natural / Inhibited)
- **Consider FGD design and operation differences in ICR data review**
- **90+% removal potential for bituminous coal**
- **Integration of mercury oxidation for low Cl coals needed**

Ongoing Wet FGD Mercury Control Work

- **Demonstration test data analysis**
- **FGD inlet mercury speciation**
  - Mercury oxidation across SCR catalyst tests
  - Fuel and flue gas additives for PRB coal
- **Fate of mercury characterization testing**
- **Wet FGD tests on other coal types**